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URBANIZATION OF LAND in the Northeastern United States

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ABSTRACT

About 85 percent of the rural land urbanized in 96 counties in 12 Northeastern States went to residential use during 1950-60. The remaining 15 percent was used for industrial, commercial, institutional, and recreational purposes, and for airports. Residential use was mainly open type; that is, land averaged above 0.5 acre per dwelling. About 50 percent of the land urbanized was cropland. Land going to urban use was largely the better farmland--about 80 percent was in land use capability classes I-III. For the entire study area, about .22 acre of land was converted to urban use for each person added to the population.

Key words: Land use, urbanization, airphoto interpretation.

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HIGHLIGHTS

During 1950-60, land in 96 counties in 12 Northeastern States shifted from rural to urban use at the rate of about 12,000 acres per year. Of this acreage, 85 percent went into residential use that was predominantly open type; that is, averaging above 0.5 acre per dwelling. Fifteen percent was used for industrial, commercial, institutional, and recreational purposes, and for airports. About .22 acre was converted to urban use for each person added to the population of the 96 counties.

About 50 percent of the land urbanized had been used as cropland, although only about 24 percent of the rural land in the entire study area was being used for this purpose in 1958. Cropland converted to urban use was largely the better farmland. About 80 percent was in land use capability classes I-III--land that is level to gently rolling and has good surface and internal drainage.

Highways were built on nearly all types of land in the study area, regardless of terrain and soil conditions.

URBANIZATION OF LAND IN THE NORTHEASTERN UNITED STATES

By

Henry W. Dill, Jr., and Robert C. Otte 1/

STUDY OBJECTIVES

The study reported on here was undertaken as part of a continuing interagency investigation of the potential for water development in the North Atlantic Water Resources Region. 2/ The intent of the study was to develop information on the quantity, quality, and prior use of land--particularly agricultural land--that had shifted to urban uses.

Specifically, the objectives were:

1. To identify and measure land converted to urban uses in the most recent period practicable.

2. To determine the prior use of land urbanized.

3. To determine the land use capability class (quality) of land urbanized.

4. To relate quantities of land urbanized to population increases.

THE STUDY AREA

The North Atlantic Water Resources Region covers an area of about 106 million acres, and in 1960 was home to some 45 million people--25 percent of the Nation's total population. For the study, 96 counties in 12 of these States were selected for intensive analysis (fig. 1). The required data were obtained by airphoto interpretation through use of sample plots of the 1958 National Inventory of Soil and Water Conservation Needs (CNI) (fig. 2). 3/

Study procedures, including a discussion of land use categories and airphoto interpretation methods, are presented in the section beginning on page 8.

1/ Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture.

2/ The region comprises 271 counties and 25 independent cities in Delaware, New Jersey, Connecticut, Rhode Island, Massachusetts, Maine, Vermont, and New Hampshire, the District of Columbia, and parts of Virginia, West Virginia, Maryland, Pennsylvania, and New York.

3/ See p. 8 for discussion of 1958 CNI.

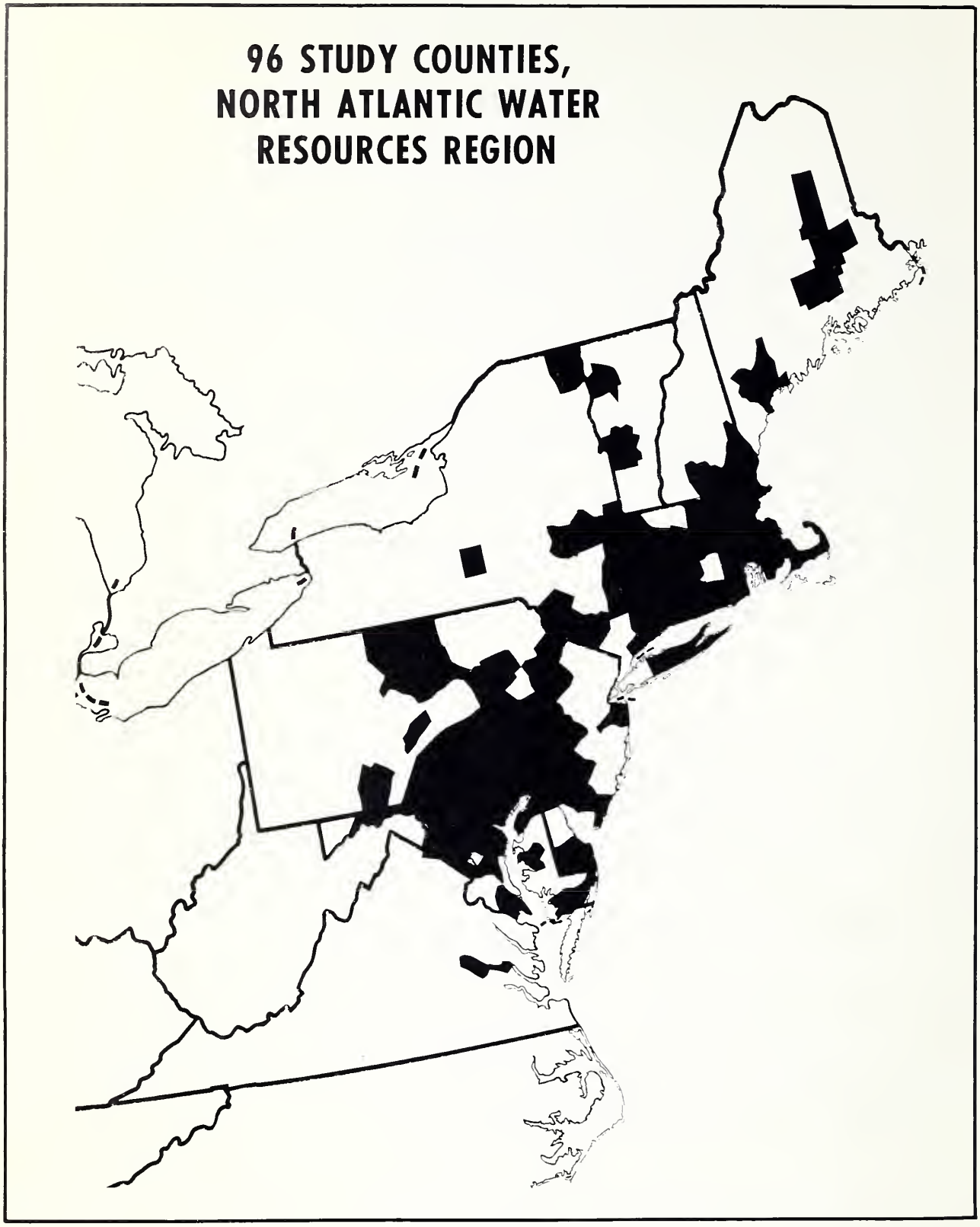

Figure 1

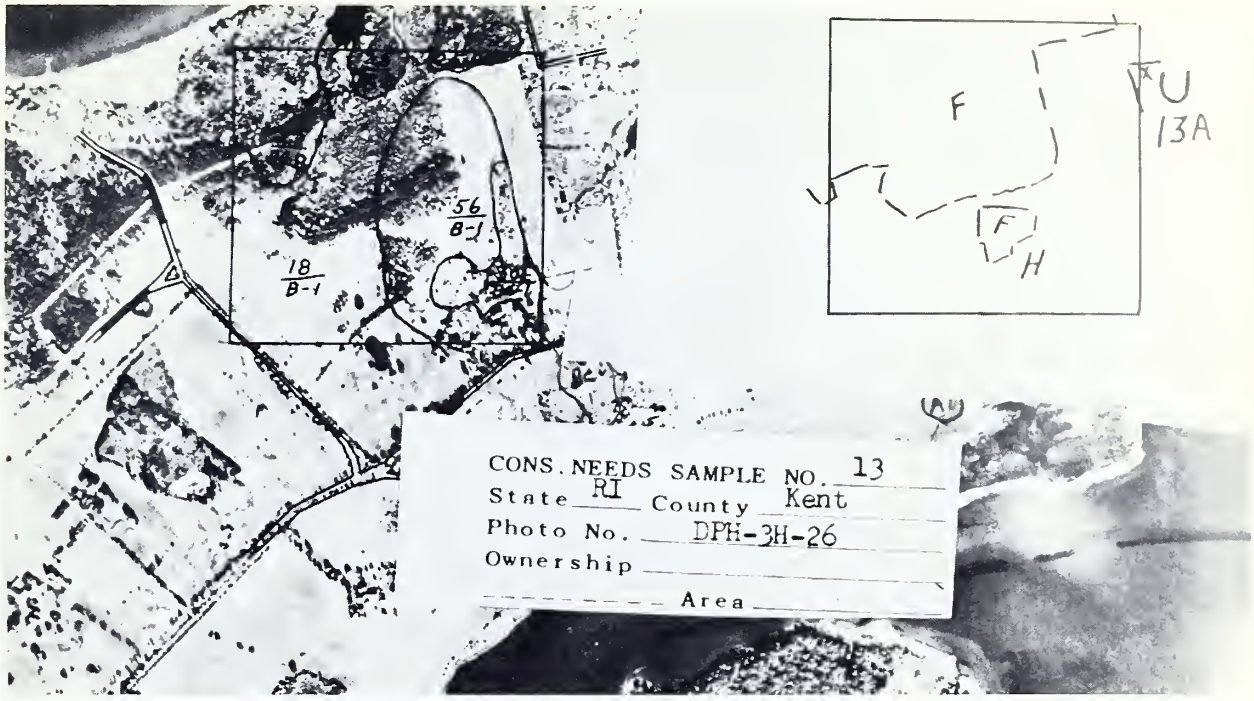

Figure 2.--A typical Conservation Needs Inventory plot with symbols indicating soil type, amount of slope, and degree of erosion. Land use is shown on separate map at the right of the outlined plot.

TYPE AND AMOUNT OF URBANIZATION

Land was urbanized for the 96-county area at an estimated average rate of about 12,000 acres per year during 1950-60. Over 85 percent of the observed shift was to residential use. About 5 percent went to industrial uses, with smaller percentages going to recreational, institutional, commercial, and airport uses (table 1).

Table 1.--SMSA status of land urbanized, by type of use, 96 Northeastern counties, 1950-60 1/

Urban use	All counties	SMSA counties	Non-SMSA counties
	----------Percent----------		
Open residential	77.6		
Dense residential	8.3	2/ 84.8	2/ 90.8
Industrial	5.5		
Other urban	8.6	3/ 15.2	3/ 9.2
Total	100.0	100.0	100.0

1/ Standard Metropolitan Statistical Areas. An SMSA is a county or group of counties defined by the Census Bureau as an entire area in or around a city or community of at least 50,000 people in which activities form an integrated economic and social system.

2/ Open and dense residential and industrial uses combined.

3/ Industrial and other urban uses combined.

Residential development was overwhelmingly (about 78 percent) composed of single-family dwellings on large lots, with blocks of development averaging no more than two houses per acre (figs. 3 and 4). The more urban SMSA counties had smaller percentages going to residential use. Some of the cities in non-SMSA counties served predominantly agricultural areas. Also, these counties included some "bedroom" communities and areas where urban development was just beginning. These communities and areas generally had proportionately less land in industrial, commercial, and intensive recreational uses, and land was used more liberally for residential construction. For each residential acre, about .14 acre was developed for other urban uses in the SMSA counties and .10 acre in the non-SMSA counties.

PRIOR USE OF LAND

About one-half the land urbanized was used for crops prior to development. Table 2 compares the proportions of the prior uses of land taken for urbanization with the proportion of these uses in the total rural area of the counties studied. While in the total rural area of the counties studied, only 23.7 percent was cropland in 1958, almost 50 percent of the land urbanized had been cropland. For most urban uses, land is preferred that is well-drained and reasonably level. These are also qualities of good cropland. Additionally, terrain too rugged for agricultural use is often impractical or expensive to develop for urban uses. Industrial and commercial uses particularly need easy access to rail or highway transportation, which is more likely to be available on the more level land.

About 60 percent of the total rural area studied was in forest in 1958. Only about 25 percent of the land urbanized had been forested prior to development. Again, much of the forest was on rough terrain not easily developed for urban uses.

Table 2.--Prior use of land urbanized and 1958 use of rural land in study area, 96 Northeastern counties, 1950-60

Type of use	Prior use of land urbanized	Use of rural land in study area, 1958 1/
	Percent	Percent
Crop	49.1	23.7
Forest	25.5	59.7
Grass	3.1	8.6
Idle (other) 2/	22.3	8.0
Total land	100.0	100.0

1/ Nonurban, non-Federal land--1958 National Inventory of Soil and Water Conservation Needs (CNI).

2/ "Other" area figure taken from CNI includes all uses other than for crops, forest, and grass.

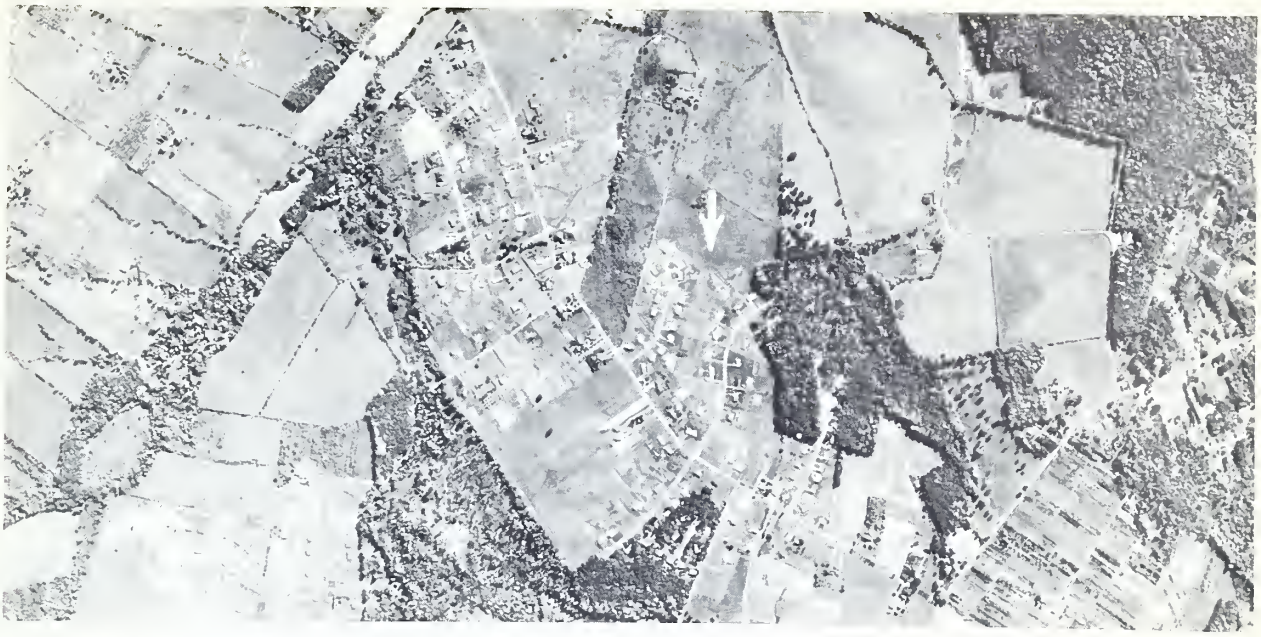

Figure 3.--The arrow indicates open-type residential development on farmland in Montgomery County, Md., adjacent to idle land (above the arrow). The average acreage per dwelling on this type of development is about 2 acres. Scale of airphoto: 1:20,000. Agricultural Stabilization and Conservation Service, U.S. Department of Agriculture.

Figure 4.--Two types of open residential development in Bucks County, Pa., are shown. In the area indicated by the upper arrow, the average acreage per dwelling is about 0.7 acre. In the area indicated by the lower arrow, the acreage is 1.2 acres. Scale of airphoto: 1:20,000. Agricultural Stabilization and Conservation Service, U.S. Department of Agriculture.

About 22 percent of the land urbanized during 1950-60 was idle and non-forested prior to conversion. Only 8 percent of the total rural land of the study counties was in this category in 1958. In the Northeast, agricultural production apparently ceases on much land some years before the land is actually converted to urban uses. This was noted in particular for many dairy farms. When a dairy farm is sold, all agricultural operations cease. In contrast, in some cash crop situations, individual fields tend to stay in production almost to the day the bulldozer arrives to begin construction for a new urban use.

QUALITY OF LAND URBANIZED

Because the 1958 CNI was used for the study, it was possible to compile data on the agricultural quality of the land urbanized. The better agricultural land was apparently bought for urban uses. Although slightly less than 42 percent of the rural land in the study area is in land use capability classes I, II, and III, over 80 percent of the land converted to urban uses during 1950-60 was in these classes (table 3). The terrain ranges from level to gently rolling, and the land has good internal and surface drainage.

Table 3.--Land urbanized and all rural land, by land use capability class, 96 Northeastern counties, 1950-60

Land use capability class	Land urbanized	Total rural area 1/
	Percent	Percent
I	3.7	2.5
II	50.7	20.5
III	26.5	18.5
Subtotal, land in I-III	80.9	41.5
IV-VIII	19.1	58.5
Total land in I-VIII	100.0	100.0

1/ Total area of study counties exclusive of urban and federally-owned land (1958 CNI).

Because of the process of land use planning, combined with modern building and sanitary regulations in many local governmental jurisdictions, attention is undoubtedly directed to development of land in classes I-III. Land in classes IV-VIII is more apt to have problems of drainage, soil slippage, and unstable subsoils than is land in classes I-III. The better agricultural land is generally more suitable for septic fields. Also, road construction and utility installation are more expensive on the steeper lands--per mile, roads are more expensive and fewer houses are served.

However, in the northern half of the North Atlantic Water Resources Region, some exceptions were observed in the use of land in classes VI and VII for urban development. These two classes include soils that developed on sands and gravels from glacial outwash and are too subject to drought for agricultural use. But when land in these classes is level, it has been used for industrial sites, airports, and some dense residential development.

An additional point about selection of land for urban development is that the developer may be interested only in the better land (classes I and II). However, most of the transfer of land to urban use is by farm ownership unit, and these units often contain land in several classes. Thus, poorer land may be withdrawn from agricultural use even if it is not actually used for development.

LAND USED FOR HIGHWAYS

Construction of the new interstate highway system began during the last years of the study period; thus, some land used for highways was observed on the sample plots. The low incidence of observed highway construction precluded statistically significant quantification. Highway routes were apparently not selective of level land. Highways were built on land with nearly all terrain and soil conditions existing in the study area.

RELATIONSHIP OF LAND URBANIZATION TO POPULATION INCREASES

The amount of land urbanized per capita population increase depends on many factors. The type of terrain affects the proportion of land area that can be utilized. Zoning laws and subdivision regulations influence lot sizes. Affluence permits people the luxury of more space around their houses. Some areas have a higher proportion of their populations living in apartments and rowhouses.

Commercial, industrial, institutional, and recreational uses of land may not be as directly related to the population within a given county as are residential uses, but one would expect a fairly close relationship in the aggregate. Business and industry both follow and are followed by customers and labor. The types of recreational use identified in the study--golf courses, drive-in movies, playgrounds, and others--are oriented to resident population. Some institutional uses, such as colleges and mental institutions, may have a State or regional orientation. However, for multicounty areas, these factors tend to average out.

Amounts of urbanized land identified by airphoto interpretation represent a minimum measure of urban impact. Only that area with visible change was counted. Land dedicated to extensively used parks or open spaces was not included. Nor was land that is indirectly affected; for example, agricultural land on which production has been curtailed to accommodate urban neighbors.

For all 96 counties, about .22 acre was converted from rural use to residential, institutional, commercial, industrial, recreational, and airport uses for each person added to the population of these counties. SMSA counties

showed .20 acre converted per capita population increase. Non-SMSA counties had a rate twice as high--.40 acre per capita. Generally, these less urban counties had fewer high-density developments; in many cases, single houses were on large lots.

PROCEDURES

Use of the Conservation Needs Inventory

The 1958 CNI was the best source of data on the quality of land being converted to urban uses. 4/ In this inventory, a sample of plots (100 acres in the Northeast and 160 acres elsewhere) was selected for each county. The universe was the land area of each county excluding Federal land, urban and built-up areas, and water areas of over 40 acres. The sample was stratified geographically. Each county was divided into subareas of equal size, and sample plots were selected at random from each subarea. The target sampling rate was 2 percent. Exact expansion factors were computed for each county. 5/ Each sample plot was inspected in the field and delineations were made on airphotos of soil, slope, land capability class, and major land use (fig. 2).

Selection of Counties

A preliminary review was made of the CNI sample plots in the counties of the Northeastern States studied to identify those counties showing urbanization during the 1950's. Counties (or boroughs) already highly urbanized were eliminated at the outset because no data had been compiled on them for the CNI. Some counties were omitted because available airphoto coverage did not permit a usable span of years for interpreting change. Airphotos of the annotated sample plots were available on microfilm, making them relatively easy to screen for evidence of urbanization. The preliminary review resulted in the selection of 96 counties for intensive study.

Land Use Categories

Four categories of rural use and seven types of urban use were identified:

Rural Land Uses

Cropland--row crops, close-grown crops, hay, and orchard
Grassland--permanent pasture
Idle land--unused open land 6/
Forest--areas substantially covered by trees

4/ The only other systematic source of data on land quality is the soil survey of the Soil Conservation Service, U.S. Department of Agriculture. However, surveys have not been made of all counties.

5/ See Conservation Needs Inventory Committee of the U.S. Department of Agriculture. Agricultural Land Resources--Capabilities, Uses, Conservation Needs. U.S. Dept. Agr., Stat. Bul. 317, Aug. 1962.

6/ The category "idle land" is limited to nonwooded areas and includes cropland and pasture not in production immediately before they were shifted to urban uses.

Urban Land Uses

Dense residential--development housing on small lots; apartments; and townhouses (fig. 5)
Open residential--averaging one-half acre or more per dwelling (figs. 3 and 4)
Institutional--schools, hospitals, and government buildings
Commercial--mainly shopping centers
Industrial--all types of industry, storage yards, auto graveyards, and gravel pits
Recreational--parks, golf courses, drive-in theaters, racecourses, and playgrounds
Airports

Quantities of rural land identified as shifting to industrial, commercial, recreational, and airport use were small, and expected sample errors were judged to be too high for separate presentation. For the same reason, open and dense residential uses were combined and industrial use was included with other nonresidential uses for statistics on SMSA and non-SMSA counties.

Airphoto Interpretation

Data on land use change were obtained for a period as nearly coincident as possible with the period covered by the population censuses of 1950 and 1960. Ideally, airphotos taken in 1950 and 1960 would be used; however, for many of the counties studied, no airphotos had been made for either year.

The CNI sample plots afforded, in most cases, an opportunity to obtain information on land use change from one airphoto for each plot. In 1958, information was obtained in the field for each plot and was recorded on earlier airphotos, many of which had been taken during 1948-52. Thus, land use change for a 6- to 10-year period could be interpreted from these airphotos and accompanying plot data. In many cases, it was possible to make the interpretation by projecting from the microfilm of the airphotos. The time periods used in the study averaged 8.6 years in length.

For each plot showing a change from rural to urban use, acreage data were recorded on prior use, new urban use, and land use capability class. Also, data were recorded on the amount, prior use, and land use capability class of land used for highways.

Expansion of the Sample

Expansion factors were computed and sample data expanded for each county. Since dates of the airphotos varied by county, data were converted to an annual basis and tabulated for multiple-county areas. Expansion of the sample indicated the average rate at which land was urbanized for the 96 counties during 1950-60 (12,000 acres per year). Total CNI acreage for the 96 counties (nonurban, non-Federal land) was about 32 million acres.

Figure 5.--Dense residential development in suburban Hartford, Conn., along with a school (lower left-hand corner) and a shopping center (low center).

The sampling rate (2 percent) used in the CNI was designed to yield reliable statistics on certain soil and land use characteristics at the county level. In the study, CNI data were combined for several counties, which should make the data more accurate; that is, standard errors should be less. For this reason alone, CNI data used in this report should accurately reflect actual land use changes for the study area, since the smallest area for which a statistic was used comprised 39 counties.

On the other hand, the sample technique used in the CNI did not provide good estimates at the county level for minor land uses or other characteristics having low rates of prevalence within a county. Again, this loss of accuracy was compensated for in part by combining counties into larger study units. However, many urban land uses had very low prevalence rates even when aggregated for all 96 counties.

The combined effects of sample size and prevalence rates on relative sample error are illustrated in table 4. The sample sizes approximate the number of plots found in the non-SMSA counties (3,200), SMSA counties (4,300), and all 96 counties (7,500). The prevalence rate--.001--corresponds to 11 percent of the land urbanized in the non-SMSA counties, 3 percent in the SMSA counties, and 4 percent for all rural land in the study area.

Table 4.--Expected relative sample error (+ or -) for selected sample sizes and prevalence rates 1/

Sample size (number of plots)	Prevalence rate		
	.001	.010	.100
	Percent	Percent	Percent
3,000----------	48	15	5
4,000----------	41	13	4
7,000----------	31	10	3

1/ At the 95-percent confidence level.

Source: Adapted from Taylor, Howard L. Statistical Sampling for Soil Mapping Surveys: A report on research sponsored by the Soil Conservation Service. U.S. Dept. Agr., Stat. Laboratories, Iowa State College, Ames, Iowa, Sept. 1958, p. 122. Taylor's report was based on 160-acre plots while those in the study counties were 100 acres in size. However, the table gives a general indication of the reliability of the sample for specific attributes of specific areas.

As an example of the use of table 4, if the CNI sample estimates that 9.2 percent of the land urbanized (prevalence rate of about .001) in the non-SMSA counties (3,000 sample plots) was for uses other than residential (table 1), the estimated relative sample error associated with that estimate would be ± 48 percent. That is, the value is estimated to be between 4.5 percent and 14 percent at the 95-percent confidence level (two standard errors). If the CNI sample estimates that 3.1 percent of the land urbanized (prevalence rate of about .001) in the SMSA counties (4,000 sample plots) was previously in grass (table 2), the estimated relative sample error would be ± 41 percent. This means the value is estimated to be between 1.7 percent and 4.5 percent at the 95-percent confidence level.

An example of a use with a greater prevalence rate would be the estimate that for all rural land in the study area, 49 percent of the land urbanized was previously cropland (table 2). This estimate represents a rate of just over .010, with a sample size of 7,000 plots. Estimated sample error would be ± 10 percent, or between about 45 percent and 55 percent at the 95-percent confidence level.

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